

NOTES ON SOME TETRARHYNCHID PARASITES FROM CEYLON MARINE FISHES

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The material on which this paper is based was collected by the author from various species of Elasmobranch fishes trawled on the Ceylon Pearl Banks during the years 1906 to 1911. A large number of larval forms were also obtained from bony fishes, but, owing to the fact that the proboscides were only rarely extruded, it has not been possible to identify them except in one or two cases. Unfortunately the major part of the writer's collection has been lost and no other material is obtainable; several species obtained by Herdman and Hornell from the same region have been described by Shipley and Hornell in Herdman's Ceylon Pearl Oyster Reports. As far as the writer is aware the only Trypanorhynchids available are in the collections of Professor Pintner of Vienna and Professor Linton in America.

A very large number of *Tetrarhynchids* have been described from time to time, often from larval forms; the descriptions are, however, so imperfect that it is impossible to identify the majority of these worms again from the meagre details given. Very few of the type species at present exist, with the result that there is great confusion. Until large quantities of material have been collected it will not be possible to revise this Order satisfactorily. The writer has merely attempted to place the classification of the TRYPANORHYNCHA on as satisfactory a basis as is possible in the present state of our knowledge and, in addition, has given a description, for the first time, of the anatomy of a few species.

The writer is indebted to Professor James Johnstone, Oceanographical Department, University of Liverpool, for specimens of two or three species.

CLASSIFICATION

Rudolphi (1809) erected the genus *Tetrarhynchus* and included it in his Order **Cestoidea**; he ascribed to the genus the following characters:—

‘Body flat and continuous; head furnished with two bipartite bothridia with four retractile armed proboscides.’

In the year 1819 Rudolphi erected the genus *Rhynchobothrius* to include *Bothriocephalus corrolatus* and *B. paleaceus*, but he did not define its characters.

Van Beneden (1850) included the genus *Tetrarhynchus* in his *TETRAPHILLES* and in his division PHYLLORHYNCHIENS; he defined the characters of the family as follows:—

‘These animals are characterised in the first place by the four bothridia which are common to the whole section and to which correspond four retractile proboscides, armed with hooks disposed in spirals and lodged in a membranous sheath. There is always a distinct neck; the longitudinal canals traverse the entire length of the head and strobila, commencing in the interior of the bothridia.’

He referred to the genus thus:—

‘As I only know one genus in this family it is useless to enumerate its characters.’

Van Beneden further stated that the genus *Tetrarhynchus* included those forms which, in the larval stage, are destitute of a vesicle, and that the genus *Rhynchobothrium* included mature worms possessing segments. As the name *Tetrarhynchus* has priority he considered the name *Rhynchobothrius* to be a *nomen nudum*.

Diesing (1850) placed the *RHYNCHOBOTHRIA* as a sub-tribe of the *BOTHRIOCEPHALIDEA* and divided it into the following genera :—

Dibothriorhynchus with two opposite bothridia ; body continuous.

Tetrarhynchus with two opposite bothridia, each bothridium being divided by a longitudinal septum.

Rhynchobothrium with two opposite bothridia ; body articulated.

Tetrabothriorhynchus with four bothridia, opposite, in pairs, apices converging.

Stenobothrium ; with four lateral opposite bothridia, body continuous.

Tetrarhynchobothrium ; with four lateral opposite bothridia ; body segmented.

Synbothrium ; with four terminal, cruciform, opposite bothridia joined to the head posteriorly by a membrane.

The same author in 1863 classified the Tetrarhynchids as follows :—

Section PARAMECOCOTYLEA.

Tribe *Paramecocotylea aprocta*.

Sub-tribe *Trypanorhyncha*. Head with four boring proboscides armed, and retractile into the neck.

Family DIBOTHRIORHYNCHA (characters not defined).

‘Genus *Rhynchobothrium*. Body articulated ; head with two bothridia facing each other, lateral or marginal, complete and divided by a longitudinal septum ; four armed proboscides. Neck tubular ; male pore marginal, female lateral, or both marginal. In intestine of marine fishes.’

Family TETRABOTHRIORHYNCHA.

‘Body articulated ; head with four lateral bothridia facing each other in pairs, or standing out terminally, disposed crosswise ; four free armed proboscides ; or singly traversing the bothridia ; neck tubular. Genital pores marginal or lateral. Parasitic in marine fishes.

Genus *Tetrarhynchobothrium*. Body articulated ; head with four lateral bothridia opposite each other in pairs ; four free proboscides. Pores marginal or lateral. Parasitic in marine fishes.

Genus *Syndesmobothrium*. Body articulated ; head with four terminal prominent bothridia placed crosswise ; four proboscides, each one running through the middle of a bothridium. Pores marginal (?). Parasitic in marine fishes.’

Carus (1863) included the genus *Tetrarhynchus*, Cuvier (?) in the sub-family ‘*PHYLLORHYNCHIDEA*,’ van Ben., of the Family ‘*TETRAPHYLLIDEA*.’ He stated that the characters of the genus were similar to those of the sub-family, viz. :—

‘The scolex is separated from the strobila by a neck, and has four suckers, sometimes joined in pairs ; four proboscides always armed with hooks which can usually be drawn back into sheaths.’

In 1864, Cobbold erected the family TETRARHYNCHIDAE with characters as follows :—

‘The members of this family are easily recognised by the possession of four armed retractile proboscides attached to the head. The armature consists of several successive rows of sharply-pointed, recurved hooks, frequently amounting to several thousands. The head itself is usually more or less bilobed, each half supporting either one bipartite bothrium, or else two separate fossae. These cavities are also frequently supported on four petaloid appendages, which vary much in shape in the different species, and also in the same individual, according to the degree of contraction of the part. The head and neck are continuous, and usually about the same breadth as the body, the latter being sometimes even narrower than either the head or neck. The body is depressed, filiform, distinctly segmented, and usually of great length in the mature state, the reproductive orifices being situated at the lateral margin of the joints in an irregularly alternate manner.’

Linton, 1889, sub-divided the family as shown below :—

Family TETRARHYNCHIDAE, Cobbold, 1864.

Synonyms :—Sub-tribe *Trypanorhyncha*, Diesing, 1863.

Sub-family *Phyllorhynchinae*, van Ben.

Sub-family I. DIBOTHRIORHYNCHINAE, Mont., 1892.

Synonym :—*Dibothriorhynchidae*, Dies.

Genus *Rhynchobothrium*, Rudolphi, 1819.

Synonym :—*Tetrarhynchus* of authors.

‘Body taeniaeform. Neck tubular. Head continuous with neck, with two opposite bothria, parallel or converging at the apices, lateral or marginal, entire or undivided, or either bilocular with a longitudinal partition, or bilobed or divided. Proboscides four, terminal, filiform, armed, retractile in the neck, for the most part longer than the head. Genital apertures, male marginal, female lateral, or male and female marginal approximate.’

Genus *Otobothrium*, Linton, 1889.

‘Body articulate, taeniaeform, head separated from body by a neck. Bothria two, opposite, lateral, each with two supplemental ciliated pits at the posterior free angles. Proboscides four, terminal, filiform, armed, retractile in neck. Reproductive apertures marginal.’

Sub-family II. TETRABOTHRIORHYNCHINAE, Mont., 1888.

Synonym :—*Tetrabothriorhynchidae*, Dies., 1863.

Genus *Tetrarhynchus*, Rudolphi, 1809.

Synonyms :—*Bothriocephali* spec., Bartels ?

Rhynchobothrii spec., van Ben. and R. Leuckart.

Tetrarhynchi spec., van Ben.

Aspidorhynchus, Molin, 1858.

Tetrarhynchobothrium, Dies.

‘Body articulate, taeniaeform. Neck tubular. Head with four bothria in two lateral pairs, parallel with the head. Proboscides four, terminal, filiform, armed, retractile in the neck, free, *i.e.*, not running through the bothria. Genital apertures marginal or lateral.’

Genus *Syndesmobothrium*, Diesing, 1854.

'This genus is characterised by Diesing as follows :—Body articulate taeniaeform ; neck tubular, rounded at the base ; head tetragonal, with four terminal prominent bothria attached to head by posterior margin, cruciformly disposed, oval, slightly convex, joined with each other at the base by a membrane ; proboscides four, filiform, armed, each one running through a bothrium (pedicel) excurrent at apex, long, retractile in the neck. Genital apertures marginal (?). In the intestines of marine fishes of tropical America.'

Loennberg, in 1889, erected the COENOMORPHINAE as a sub-family of the TETRARHYNCHIDAE. Type and only species *C. grossus* (Rud.) = *T. linguatulus* (van Ben.) = *T. solidus*, Drummond, 1838. Larvae have been recorded in Decapods.

The principal characters of the sub-family are :—(1) the presence of a double set of genitalia in each segment, and (2) the fact that the worms are very stout and muscular.

Braun (1900) defined the Order **Trypanorhyncha**, Diesing, 1863, as follows :—

'The scolex is divided into head and neck ; head with two or four bothridia and with four retractile and armed proboscides ; segmentation complete, segments usually dividing off before maturity. Pores marginal or sub-marginal, uterine pore ? Genitalia as in TETRAPHYLLEA. Larvae in different marine animals, adults usually in the guts of Plagiostomes.'

He placed the following genera in the family ; an abstract of his definitions is given below :—

Rhynchobothrius, Rud.

This is the oldest genus, erected to accommodate the species *Bothriocephalus corollatus* and *B. paleaceus*, Rud. The author only saw drawings of these species. He discusses the question as to whether *B. corollatus* and *Taenia corollata*, Fab., are synonymous, but says too little is known to decide. *R. corollatus* is selected as the type species. It has two simple bothridia with four proboscides at the four corners, each proboscis being furnished with 20 to 30 hooks bent posteriorly.

Dibothriorhynchus, de Blainv., 1824 (as appendix to French translation of Bremser).

The drawing shows an unsegmented cestode with a posterior tubercle, two bothridia with a posterior longitudinal septum, two short, retractile proboscides armed with small, bent hooks. Later on the worm was named *D. lepidopteri*. The author considers two proboscides a mistake of the observer, or else, according to Loennberg, it was a larval form. Loennberg's observations enable the following amended description to be given :—

'TRYPANORHYNCHA with four, short, thick, club-shaped or half-circular retractile proboscides armed with hooks ; and two sessile, powerful suckers ; segmentation complete ; segments very muscular, always broader than long, not dividing off ; genitalia double in each proglottis, each set having three pores ; cirrus and vagina marginal, uterus ventral. Larvae not encysted ; adult in stomach of Selachiens.'

Diesing set up another genus *Dibothriorhynchus* for *Tetrarhynchus scolecinus*, Rud., and *T. gracilis*, Rud. (i.e., larval forms), but adult forms have also received the name ; they really belong to the genus *Rhynchobothrius*. Thus Diesing's *Dibothriorhynchus* is a synonym of *Rhynchobothrius*.

Tetrarhynchobothrium, Dies. Type species *T. tenuicolle*, Diesing, but four other species were added to this genus later on.

Characters of the genus are :—Cylindrical neck, four bothridia, four thread-like proboscides, and irregularly alternating marginal pores ; ripe segments longer than broad. *Tetrabothriorhynchus*, Dies., is a synonym of this genus.

Aspidorhynchus, Mol.

Contains one species only, viz., *A. infulatus*, Mol. Diesing placed it in the genus *Tetrarhynchobothrium*. Molin's characteristics include the form and position of the bothridia and a telescopic, retractile neck ; these characters are not sufficient to justify the retention of genus *Aspidorhynchus*.

Synbothrium, Diesing. Diesing later on changed the name to *Syndesmobothrium*.

Characters :—Four oval, convex bothridia placed crosswise on the surface of the head and bound together by a basal membrane ; four, thread-like proboscides, which traverse the longitudinal axes of the bothridia and emerge anteriorly. Genital pores marginal. *Synbothrium fragile*, Dies., was for a long time the only species, but Linton described *S. filicolle*, though he has not described it sufficiently, as the specimen was not mature. Host :—*Trygon centrura* (spiral valve).

Abothros, Welch. Only species :—*A. carcharias*, Welch. from *Carcharias*, sp.

Chief characters :—Alleged absence of bothridia ; the four, slender proboscides are armed with hooks bent backwards, emerging close together on the ventral surface of the head. Segments very short. Genital pores ? Certain longitudinal furrows could be seen on the scolex, probably the missing bothridia. *A. carcharias*, Welch, is probably identical with *Bothriocephalus bicolor*, v. Nordm.

Otobothrium, Linton. The only species is *O. crenacolle*, Linton.

Characters :—Two ventral bothridia with longitudinal septum, each of which bears on its free posterior edge, two little suckers. Four, thread-like proboscides, pores marginal.

Lühe (1910) defined the Order **Trypanorhyncha** thus :—

'Cestodes whose scolex is usually continued into a *Kopfstiel* ; with two or four bothridia at whose apical end are four armed extensile proboscides. When retracted (with the assistance of a retractor which runs in their interior and is inserted into their anterior end) each is drawn back into a proboscis sac. This corresponds in thickness and length with the proboscis itself and represents a direct continuation of the proboscis into the anterior end of the scolex and *Kopfstiel*. At its inner end, the sheath passes directly into the visibly thicker, sharply delineated, egg-shaped or sausage-shaped sac, whose contraction brings about the extrusion of the proboscides. Outer segmentation complete. Formation of segments as in TETRAPHYLLEIDA ; mature in stomach or spiral valve of Selachiens ; larvae found in all kinds of marine animals. In fresh water only a few species are found in the larval condition as parasites of Teleosts. No details of the development of the larvae are known.'

Lühe distinguished two families, viz. :—

1. Larva encysted ; proboscis long, slender, cylindrical, whole body not massive or muscular..... *Tetrarhynchidae*,
Lühe, 1910
2. Free larvae, not encysted ; proboscis short ; almost semi-globular or club-shaped ; whole body robust and muscular..... *Coenomorphidae*,
Lühe, 1910

He ascribed the following characters to the TETRARHYNCHIDAE :—

‘Scolex with long, slender, cylindrical, very mobile proboscides, with two or four very mobile bothridia more or less leaf-like. *Kopfstiel* present. Strobila slender, with little muscular development; often transparent. Segments, when mature, longer than broad, easily detachable; in each segment a single set of genital organs. Uterus apparently without primary pore. Ripe eggs, as in TETRAPHYLLIDEA, escape through dehiscence. In spiral valve of Selachiens; larvae in Turtles, Bony fish, Cephalopods and Decapods.’

He added that nothing was known regarding the systematic division of the family.

The family COENOMORPHIDAE, he defined as follows :—

‘Scolex very robust with short, thick proboscides, semi-globular or club-shaped, with two simple bothridia sunk into the scolex like a pit or a split, and with edges which hardly protrude; no *Kopfstiel*. Strobila robust and very muscular, up to 4 mm. in thickness and not transparent; segments when mature much broader than long and not separating off. In each segment there are two sets of genital organs; uterus with a special pore opening ventrally and having its own muscular system. Mature in stomach of sharks; larvae, not encysted, found in bony fish. There is only one genus with one species, viz., *C. grossus* (Rud.) = *T. solidus* = *T. linguatulus*.’

Pintner (1913) in dealing with Tetrarhynchids in general, pointed out that our information relating to the anatomy of the various forms was not sufficient to enable one to deal extensively with the order, as only six species appear to be well-determined, *T. ruficollis*, Eysenh., 1829, being the best known. Specific points are hardly ever mentioned by authors who have hitherto described different species. The principal characters in distinguishing species, according to Pintner, are :—

(1) The scolex; but this is not altogether definite; the length of the part of the bothridium attached to the head is of importance, the peduncle behind the head is included as scolex. (2) The exact number and shape of hooks. (3) The form of the proboscis sacs. (4) Whether the head is separated from the neck. (5) The general appearance of the worm. (6) The specific characteristics of ripe segments. (7) The presence or absence of a uterine pore.

Pintner identified three groups, viz. :—

1. With a true uterine pore present *T. viridis* group
2. With an involuted, apparent pore, not found in anterior segments *T. ruficollis* group
3. Segments dehiscent, no uterine pore either primary or secondary *R. tenuis* group

He defined a number of genera as follows :—

Eutetrarhynchus, Pintner, 1913.

‘Scolex very long and slender, with small proboscides. The two flat, spoon-like bothridia are deeply embedded (in lateral view) and inclined to the long axis at about 45°. Proboscis bulb at least twice as long as the rest of the scolex; in this respect it resembles *T. longicollis*. The proboscides are very long and thick and are covered with a pile of small uniform hooks which look black in low magnifications owing to their small size, but this is not so when highly magnified. Proboscis not longer than proboscis sheath. The retractor lies in the fundus of the *Kolben* (knob) and is formed of parallel, closely arranged fibres in which the large constituent cells, for their whole length, and in large numbers, are arranged on one side. The very long knobs are formed of only five or six broad shells of clearly striped, transverse muscle bands, in a single layer, with large spherical myoblasts arranged on the inner side of the knobs in the form of stripes. Neck short; chain weak but markedly craspidot, seldom apolytic. Generally one or two very mature segments, or longer pieces of greater age, become detached from the chain. Frequently they retain the primary end segment. Segments at the end of the chain sometimes longer than broad. Genital pore in the middle of the margin; apparent uterine openings in the middle line on a level with the pore. The oviduct opens far in front into the uterine sac. Testes large and very numerous, occupying all the segment. Type species :—*Eutetrarhynchus ruficollis* (Eysenhardt, 1829). *E. leucomelanus*, Shipley and Hornell, 1906, also belongs to the same genus.’

Stenobothrium, (Diesing, 1863).

‘Four bothridia (two dorsal and two ventral) whose sides are furnished with very long (but not projecting) hairs; proboscides very long. In *S. macrobothrium* they are the longest of any known *Tetrarhynchid*, being several times as long as the rest of the cephalic region. Scolex markedly craspidot; proboscides weak, short, thin and thread-like, with uniform, not numerous, small hooks, rather far apart. The sheaths are correspondingly thin and short and they bear small knobs. The knobs are formed of very numerous thin muscles in six shells, each of which consists of many muscle layers, the innermost being the thinnest. In transverse section the knob muscles appear not to be arranged as usual, but to lie parallel like four horses racing side by side, the thinnest part of each muscle representing the head and the thickest part the hind end of the horse; retractor one-celled. A single, large, constructive cell occurs between the fibrillae, and these have no nuclei; their surface is covered with minute (chitin-like?) papillae. Frontal glands powerfully built. Strobila strongly developed. Even the last segments broader than long, with completely smooth sides, laterally limited by a straight line. Genital cloaca situated at the anterior end of the segment towards the ventral side; the long cirrus sac stretches the length of the anterior margin of the segment, its end being bent backwards. Uterine openings in the middle line behind one another. Vitelline glands not so dense as the testes generally are, because the ventral sides are occupied by the coils of the uterus. Ovary of two dorsal and two ventral wings, which, on each side, are sub-divided into five or six lobes; the tubes connecting these subdivisions are very thin and the wall consists of a single layer of cells; a muscular septum is present at the end of each segment. At the primary hind end (especially in the larva) there projects a conical knob from inside the bladder which is thickly covered with strong hairs, (viz., *S. macrobothrium*) or with papillae (viz., *S. linguale*). Type species :—*S. linguale*, Cuvier, 1817. Other species :—*S. macrobothrium* (Rudolphi, 1819), *T. bisulcatum*, Linton, 1889, *T. tenue*, Linton, 1890, *T. robustum*, Linton, 1890, *S. herdmani*, Shipley and Hornell, 1906, *S. perideraenum*, Shipley and Hornell, 1906. One of Linton’s species is probably identical with *S. linguale* Cuvier, 1817.’

Lakistorhynchus, Pintner, 1913.

'Head small and fragile; delicate, fine, and very pointed angle-shaped hooks occur on the soft thin proboscides. Strobila euapolytic or hyperapolytic; the segments grow a lot after separation. They are very long and, in the chain, pass very suddenly from unripe to ripe. The genital atrium is situated in the middle of the segment and is distinguished by a sucker-like pit in front and behind it. The surface of the ripe segments bears marked papillae. The proboscis sheath affords characters which are peculiar in two ways. Whereas in *benedeni* they are long and form spirals (in connection with a very contractile pars vaginalis) so that the proboscides, even in a completely withdrawn condition, do not approach by a long way the muscle knobs; in *platycephalus* and *rubromaculatus*, on the contrary, the sheaths are short and, therefore, also not in spiral, and the proboscides when fully drawn in, actually extend from the part bearing the hooks to the middle of the hollow space of the muscle knobs; consequently, the retractor in them is arranged in very dainty stripes. This divergence in scolex structure can easily be used as of generic importance. At times, also, the species are very peculiar. On the other hand there is between *benedeni* and *platycephalus* such a similarity in proglottides, and in the case of *benedeni* and *rubromaculatus* such a correspondence in the scolex that I must, for the present, place them in the same genus. Type species:—*L. benedeni*, Crety, 1890. Other species:—*L. rubromaculatus*, Diesing, 1863, *L. platycephalus*, Shipley and Hornell, 1906.'

Halsiorhynchus, Pintner, 1913.

'Probably one has to make a new genus for Shipley and Hornell's *T. ruficollis*, type species *H. shipleyanus* as the chief characters are the proboscis hooks and the "coat of mail." It is like a species I described as *Rhynchobotbrius vario-uncinatus*. Shipley and Hornell's form has not the slightest resemblance to *T. ruficollis* (Eysenhardt, 1829). The chief characteristic of Shipley and Hornell's species is the armoured chain of proboscides hooks.'

Sphyricephalus, Pintner, 1913.

'Species thick and muscular; two large, sucker-like bothridia, one dorsal and one ventral, giving the head a hammer-like appearance. Extruded proboscides rigid, thick and straight; proboscis sacs transverse; anterior extremity pointing outwards. The *attenuatus*-group shows the same character, which is also common in the larva, but in the larvae the posterior end of the sacs turns outward. Scolices craspidot; hooks almost equal in size and in 20 transverse and 16 longitudinal rows. The little hooks measure 0.009 mm. and 0.02 mm., the hooks are slightly larger in the middle, viz., 0.045 to 0.075 mm.; bases 0.048 mm. Eggs in one species are bell-shaped with two enormous processes at the poles, one is long, the other is small (47 to 65 μ long and 6 μ broad at base) and claw-shaped. Egg 75 $\mu \times$ 47 μ , one side being flattened. Type species:—*S. viridis*, Wagener, 1854. Another species:—*S. turgistensis*, Pintner, 1913.'

Attenuatus group.

Pintner did not name or define the group, but he included in it the following:—

'Genus *Coenomorphus*, Loenn., 1889; also *T. attenuatus*, Rudolphi, 1819, *T. grossus* (Rudolphi, 1819) and *T. megalcephalus*, Shipley and Hornell, 1906.

'*T. equidentatus*, Shipley and Hornell, 1906, also possibly belongs to the *attenuatus* group, or it is a transitional form between the *attenuatus* group and *Stenobothrium*.'

Otobothrium, Linton, 1890.

'Type species *O. crenecolle*, Linton, 1890. *T. carcharidis*, Shipley and Hornell, 1906, is possibly synonymous with the type species.'

Pintner gave the following synonymy for the species mentioned below :—

Tetrarhynchus leucomelanus, Shipley and Hornell, 1906 = *Eutetrarhynchus leucomelanus*.
 „ *berdmani*, Shipley and Hornell, 1906 = *Stenobothrium berdmani*.
 „ *tenue*, Linton, 1890
 „ *bisulcatum*, Linton, 1889 } = All *Stenobothrium* sp.
 „ *robustum*, 1890
 „ *platycephalus*, Shipley and Hornell, 1906 = *Latistorhynchus platycephalus*.
 „ *benedeni* = *T. tenuis* = *T. gracilis* = *L. benedeni*.
 „ *ruficollis*, Shipley and Hornell, 1906 = *Tetrarhynchus shipleyanus*
 = *Halystorhynchus shipleyanus* = *Rhynchobothrius vario-uncinatus*.

The same author adopted the terminology noted below :—
 The head is *craspidot* where there is a division between the head and the neck. It is *acraspidot* where the division is absent. Ripe segments are *anapolytic*, when they remain attached to the strobila. Ripe segments are *apolytic* when they automatically separate from the strobila. Gravid segments are *euapolytic* when they separate from the chain and continue to grow. Gravid segments are *hyperapolytic* if they separate from the strobila before they are mature and especially if they do so before the uterus is developed.

The table given below summarises the details relating to the bothridia in the different genera according to the authors noted below.

Until more material is available for examination the writer proposes the following classification.

Order **Trypanorhyncha**, Diesing, 1863, emended.

Family I. COENOMORPHIDAE, Lühe, 1910, emended.

Genus *Coenomorphus*, Loennberg, 1889, emended.

Family II. TETRARHYNCHIDAE, Cobbold, 1864, emended.

Genera :—*Tetrarhynchus*, Rud., 1809, emended.

Rhynchobothrius, Rud., 1819, emended.

Syndesmobothrium, Diesing, 1863.

Otobothrium, Linton, 1890.

The characters of the order, families and genera are given below.

TABLE I
Table of Genera

Author	Genus				Bothridia
Rudolphi, 1809 ...	<i>Tetrarhynchus</i>	...	...	...	Two bothridia; bipartite
Rudolphi, 1819 ...	<i>Rhynchobothrius</i>	...	...	...	Two simple bothridia
Blainville, 1824 ...	<i>Dibotbriorhynchus</i>	...	...	...	Two simple bothridia
Van Beneden, 1849	<i>Tetrarhynchus</i>	...	...	...	Four bothridia
Diesing, 1850 ...	<i>Dibotbriorhynchus</i>	...	...	...	Two opposite bothridia; body continuous
Diesing, 1850 ...	<i>Tetrarhynchus</i>	...	...	...	Two opposite bothridia, each bothridium being divided by a longitudinal septum
Diesing, 1850 ...	<i>Rhynchobothrium</i>	...	...	...	Two opposite bothridia; body articulated
Diesing, 1850 ...	<i>Tetrabotbriorhynchus</i>	...	...	...	Four bothridia, opposite; in pairs apices converging
Diesing, 1850 ...	<i>Stenobothrium</i>	...	...	...	Four lateral opposite bothridia; body continuous
Diesing, 1850 ...	<i>Tetrarhynchobothrium</i>	...	...	...	Four lateral opposite bothridia; body segmented
Diesing, 1850 ...	<i>Synbothrium</i>	...	...	...	Four terminal cruciform opposite bothridia joined to head posteriorly by a membrane.
Diesing, 1863 ...	<i>Rhynchobothrium</i>	...	...	...	Two bothridia divided
Diesing, 1863 ...	<i>Tetrarhynchobothrium</i>	...	...	...	Four bothridia
Diesing, 1863 ...	<i>Syndesmobothrium</i> (<i>Synbothrium</i> renamed)	...	...	...	Four terminal bothridia
Linton, 1889 ...	<i>Rhynchobothrium</i> (= <i>Tetrarhynchus</i> of authors)	...	...	...	Two bothridia; entire or sub-divided
Linton, 1889 ...	<i>Otobothrium</i>	...	...	...	Two bothridia with posterior ciliated pits
Linton, 1889 ...	<i>Tetrarhynchus</i>	...	...	...	Four bothridia
Linton, 1889 ...	<i>Syndesmobothrium</i>	...	...	...	Four terminal bothridia
Braun, 1900 ...	<i>Rhynchobothrius</i>	...	...	...	Two bothridia
Braun, 1900 ...	<i>Dibotbriorhynchus</i>	...	...	...	Two bothridia each with a septum
Braun, 1900 ...	<i>Tetrarhynchobothrium</i>	...	...	...	Four bothridia
Braun, 1900 ...	<i>Synbothrium</i> = <i>Syndesmobothrium</i>	...	...	...	—

It will be seen from the above table that the genus *Tetrarhynchus*, as originally described by Rudolphi, had two bipartite bothridia and that he applied the name *Rhynchobothrius* to forms with two simple bothridia.

Van Beneden was the first to state definitely that the genus *Tetrarhynchus* possessed four bothridia, although the fact is implied in Rudolphi's definition of the genus.

The synonymy of the two genera is therefore as follows :—

Tetrarhynchus, Rudolphi, 1809.

Synonyms :—*Tetrarhynchus*, van Ben., 1849.

Tetrarhynchus, Diesing, 1850.

Tetrabothriorhynchus, Diesing, 1850.

Stenobothrium, Diesing, 1850.

Tetrarhynchobothrium, Diesing, 1850 and 1863.

Rhynchobothrium, Linton, 1889, pro parte.

Tetrarhynchus, Linton, 1889.

Dibothriorhynchus, Braun, 1900.

Tetrarhynchobothrium, Braun, 1900.

Rhynchobothrius, Rudolphi, 1819.

Synonyms :—*Dibothriorhynchus*, Blainville, 1824.

Dibothriorhynchus, Diesing, 1850.

Rhynchobothrium, Diesing, 1850.

Rhynchobothrium, Linton, 1889, pro parte.

Rhynchobothrius, Braun, 1900.

Although it is easy to refer worms with two or four bothridia to their respective genera, there are a few species in which each bothridium is only *partially* divided and it may then become difficult to decide whether there are two or four bothridia. Such forms are to be regarded as intermediate and may be referred to either genus.

Characters of the Order **Trypanorhyncha**, Diesing, 1863, emended.

Head with two or four bothridia, and bearing four retractile proboscides armed with hooks; segmentation complete. Genital organs as in the *TETRAPHYLLIDEA*. Adult in marine Elasmobranch fishes and occasionally in Teleosts. Larvae in Teleosts and invertebrates. With two families.

Family I. TETRARHYNCHIDAE, Cobbold, 1864, emended.

Trypanorhyncha with a single set of genitalia in each segment. Worms more or less fragile. Parasitic in marine and fresh water fishes.

Family II. COENOMORPHIDAE, Lühe, 1910, emended.

Trypanorhyncha possessing a double set of genitalia in each segment; strobila stout and muscular. Parasitic in marine and fresh water fishes.

KEY TO GENERA

- | | |
|--|---------------------|
| A single set of genitalia in each segment..... | 1 |
| A double set of genitalia in each segment..... | <i>Coenomorphus</i> |
| 1. Head with four bothridia..... | 2 |
| Head with two bothridia..... | 3 |

2. Bothridia parallel with body and with posterior half free..... *Tetrarhynchus*
Bothridia terminal, cruciform, at right-angles to body ;
attached to head by posterior margin..... *Syndesmobothrium*
3. Bothridia with ciliated pits at their posterior margin..... *Otobothrium*
Bothridia without ciliated pits ; each bothridium often
more or less divided into two..... *Rhynchobothrius*

Genus *Tetrarhynchus*, Rudolphi, 1809, emended.

Head with four bothridia arranged in pairs, and lying parallel with the head.

Tetrarhynchus tetrabothrius (van Ben., 1849).

Several specimens from *Acanthia vulgaris*, North Sea, August, 1923, collected by the author ; also from the dog-fish, Isle of Man, collected by Mr. Birtwistle.

Tetrarhynchus perideraeus, Shipley and Hornell, 1906 (figs. 1 to 3).

This species, according to Shipley and Hornell, measures up to 70 mm. in length and 1.3 mm. in breadth. The head bears two lappets, but they are so divided in the centre as to appear like four ; the proboscides are slender and bear oblique rows of very minute teeth all of uniform size ; the proboscis tubes and proboscis sheath



FIG. 1. *Tetrarhynchus perideraeus*.
A hook. $\times 1125$.

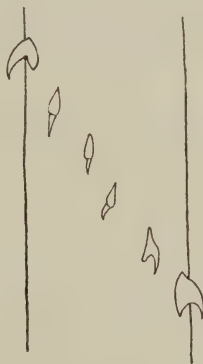


FIG. 2. *Tetrarhynchus perideraeus*. A row
of hooks on proboscis. $\times 500$.

are also short. The head is produced backwards into a very characteristic collar which overlaps and embraces the anterior part of the body. The neck is fairly long ; the segments have straight sides, except posteriorly ; the middle portion of the strobila shows a

tendency to become coiled or twisted ; the genital pores are irregularly alternate and are situated about the middle of the lateral margin. The species was obtained from the intestine of *Carcharias gangeticus*.

The writer obtained a few specimens of this species from the intestine of *Ginglymostoma concolor*, Pearl Banks, Ceylon, 27th February, 1909, and adds the following notes on the anatomy of the species :—

EXTERNAL ANATOMY. The *head* measures about 1.36 mm. in length and 0.85 mm. in breadth ; the hooks are spirally arranged and measure 16μ ; neck absent. There are a large number of segments having convex margins ; the genital pores are lateral and irregularly alternate, being situated a little in front of the centre.

INTERNAL ANATOMY. *Testes.* The testes vary in number from 60 to 70 ; they occupy the entire dorsal area within the

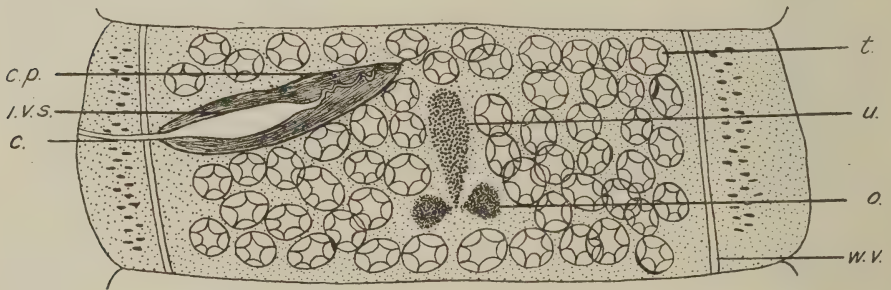


FIG. 3. *Tetrarhynchus perideraeus*. Mature segment. *t.*—testes ; *u.*—uterus ; *o.*—ovary ; *w.v.*—water vessel ; *c.*—cirrus ; *i.v.s.*—internal vesicula seminalis ; *c.p.*—cirrus pouch. $\times 112$.

excretory vessels and a few testes are situated posterior to the ovary.

Vas deferens. The cirrus pouch is conspicuous and lies anterior to the vagina and median to the excretory vessels ; it communicates with the exterior by means of a long narrow duct. In the median direction it extends almost half-way across the segment, its median extremity being closely apposed to the anterior extremity of the segment ; no spines were observed on the cirrus. The vas deferens lies coiled within the cirrus pouch, near the median extremity of which it dilates into a seminal vesicle.

Ovary. This is peculiar in being situated some distance from the posterior extremity of the segment, and in being small and dumb-bell

shaped ; it stains very deeply and the two lobes are very compact. The vagina runs posterior to the cirrus pouch.

Vitelline glands. These are very scanty and consist of single acini practically encircling the segment.

Uterus. This consists of a sac with irregular walls which completely fills the segment ; it was full of immature eggs.

Tetrarhynchus aetobatidis, Shipley and Hornell, 1906.

One specimen, immature, was collected by the author from the intestine of *Trygon kuhli*, Ceylon Pearl Banks, 1909.

This species is easily identified on account of the fact that (1) the head is swollen, the swelling being due to the stout muscular proboscis sacs ; (2) there is a deposit of pigment (present in preserved specimens) at the junction of the proboscis tubes with the proboscis sacs.

As the specimen was immature, the anatomy is not known.

Tetrarhynchus sp.

The larval form of the species about to be discussed occurs in the Ceylon Pearl Oyster and was originally believed to be concerned in pearl production. The writer has recently (1924) summarised our knowledge relating to the pearl-inducing parasite in the Ceylon pearl oyster, except with regard to the *Tetrarhynchus* larva. At least three different species of larval cestodes inhabit the tissues of the pearl oyster. Two of these are globular and belong to the genus *Tylocephalum*, whilst the third is elongated and belongs to the genus *Tetrarhynchus*. There can be no doubt that the larval parasites concerned in pearl production belong to the former genus ; the larval Tetrarhynchid is confined almost exclusively to the gut wall of the oyster ; Shipley and Hornell (1904) described the adult of this larva as occurring in *Rhinoptera javanica*, and they named the adult worm *Tetrarhynchus unionifactor*. All the three larval forms found in the pearl oyster were believed by Shipley and Hornell, without sufficient reason, to be young forms of the adult *Tetrarhynchus unionifactor* found in *Rhinoptera javanica*. For reasons given by the writer in the paper referred to above, the specific name *unionifactor* is now restricted to the adult form of the larger globular larva found

in the pearl oyster, which is now known as *Tylocephalum unionifactor*; in all probability *Tylocephalum dierama*, Shipley and Hornell, 1906, is a synonym of *T. unionifactor*. The Tetrarhynchid larva found in the pearl oyster is therefore without a name.

As a result of feeding sharks and rays with infected pearl-oysters the writer, on two occasions, obtained large numbers of an adult Tetrarhynchid, which, at the time, he believed to be identical with *Tetrarhynchus unionifactor*, Shipley and Hornell, 1904.

Unfortunately, nearly all the material has been lost and it is therefore impossible to describe the adult worm until more material is available. The adult worms obtained by the writer differ, however, from the worm described by Shipley and Hornell in having four instead of two bothridia, and in the hooks not being all alike as they are stated to be in Shipley and Hornell's worm.

Professor Th. Pintner, of Vienna, has been good enough to examine the fragments of adult worms obtained by the writer from *Ginglymostoma concolor*, as a result of feeding experiments, and he is of opinion that the species belongs to his genus *Latistorhynchus* because (1) the head is small and delicate, (2) the proboscides are long, the hooks fine and pointed, and (3) the proboscis sheaths are spiral. The scarcity of material did not allow of a definite identification, but the species is close to, but different from *L. benedeni*, Crety, 1890. Shipley and Hornell state that in their larval form of *Tetrarhynchus unionifactor*, the body is covered with warts and this feature is, according to Pintner, one of the characteristics of the genus *Latistorhynchus*. It is quite possible that Shipley and Hornell's species, and that obtained by the writer, belong to the same genus, but they are certainly different species, and the writer's specimens are closely related to, if not identical with, *Tetrarhynchus rubromaculatus* (Diesing), Shipley and Hornell, 1906.

Genus *Rhynchobothrius*, Rud., 1819, emended.

Body taeniaeform. Head with two lateral or dorso-ventral bothridia, each bothridium being either entire, or partly divided.

Rhynchobothrius erinaceus (van Ben., 1858).

SYNONYMS :—*Rhynchobothrium imparispine*, Linton, 1890.
Rhynchobothrium simile, Linton, 1909.
Tetrarhynchus gangeticus, Shipley and Hornell, 1906.
Tetrarhynchus annandalei, Hornell, 1912.

Very numerous specimens from the spiral valve of *Trygon* sp., Ceylon Pearl Banks, 1910. Collected by the author.

Shipley and Hornell, in 1906, under the name *T. macroporus*, described a worm which appears to differ from *R. erinaceus* only in having the bothridia

‘Each divided into two, each half corresponding with one of the four hooked proboscides.’

The writer has had the opportunity of examining the type (and only) specimen of *R. annandalei* obtained from *Stegostoma tigrinum*.

The proboscides were not extruded and the shape of all the hooks could not be determined; it was noted, however, that they were of various shapes, many of them being large. The testes are numerous and the pores are irregularly alternate, large, and situated in the posterior third of the segment. The worm is indistinguishable from *R. erinaceus*.

Rhynchobothrius macrocephalus (Shipley and Hornell, 1906) (fig. 4).

SYNONYMS :—*Tetrarhynchus macrocephalus*, Shipley and Hornell, 1906.
Tetrarhynchus ruficollis, Shipley and Hornell, 1906.

Numerous specimens from the intestine of *Rhynchobatus djeddensis*, Ceylon Pearl Banks, February 3rd, 1911; also from *Trygon walga*, November 27th, 1910. Collected by the author.

Shipley and Hornell described this species from a young form which was quite immature, and which measured 8 mm. only in length. The head measured 6 mm. in length and the rest of the body 2 mm. They called attention to the fact that the distinctive character of this species was

‘The herring-bone spicules on the proboscides and the grading of the hooks on the same.’

Pintner, who examined the type species, states that *T. macrocephalus* is the same as the mature worm measuring 40 mm. to 50 mm., identified by Shipley and Hornell, as *T. ruficollis* (Eysenhardt, 1829), and with this statement the present writer is in agreement. Pintner

further points out that the worm identified by Shipley and Hornell as *T. ruficollis* (Eysenh.) is quite a different species from that described by Eysenhardt.

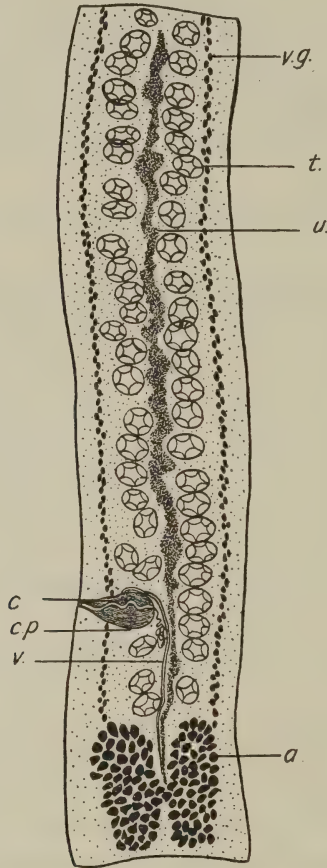


FIG. 4. *Rhyncobotrius macrocephalus*. Mature segment. *v.g.*—vitelline glands; *t.*—testes; *u.*—uterus; *c.p.*—cirrus pouch; *c.*—cirrus; *o.*—ovary; *v.*—vagina. $\times 69$.

Pintner erects a new genus which he names *Halsiorhynchus* to accommodate Shipley and Hornell's *T. macrocephalus* and he also changes the specific name to *shipleyanus*.

For reasons which are stated elsewhere, the writer is of opinion that Pintner's classification cannot be accepted until more is known regarding the morphology of the **Trypanorhyncha** generally, and

further, the changing of the specific name to *shipleyanus* is clearly contrary to the accepted rules of nomenclature. Pintner states that

'One has to make a new genus for Shipley and Hornell's *T. ruficollis* (type species *Halsiorhynchus shipleyanus*) as the chief characters are the proboscis hooks some of which are arranged like "a coat of mail or armoured chain" (herring-bone type). It is like a species I described as *Rhynchobothrius vario-uncinatus*. Shipley and Hornell's form has not the slightest resemblance to *T. ruficollis* (Eysenh.).'

As *T. macrocephalus* was described first, and as it is identical with the worm which Shipley and Hornell called *T. ruficollis* (Eysenh.), it is clear that the specific name *macrocephalus* must stand.

As the anatomy of the worm has not been described, the following notes are now added :—

The worms measure up to 50 mm. in length ; there is nothing to add to the description of the head except that there are two bothridia only. There is no neck. The worm is composed of about thirty-five segments and the genital pores are irregularly alternate and situated in the posterior third of the segment. There are about fifty-five testes ; the *cirrus pouch* extends almost to the median longitudinal axis of the segment. The *ovary* is bilobed, each lobe consisting of about fifteen large acini. The *oviduct* is short and appears to run anterior to the pouch. In segments mounted entire, the *vitelline glands* appear to consist of a single row of acini running along the lateral margins, but they actually encircle the entire segment. The *uterus* at first consists of an irregular tube running in the median antero-posterior axis of the segment. It eventually becomes bag-shaped and entirely fills the segment.

Rhynchobothrius rhynchobatidis, Shipley and Hornell, 1906
(figs. 5 to 9).

SYNONYMS :—*Tetrarhynchus rhynchobatidis*, Shipley and Hornell, 1906.
Rhynchobothrium curtum, Linton, 1909.

Three specimens from the intestine of *Trygon sephen.*, Ceylon Pearl Banks ; collected and presented by James Hornell, Esq., F.L.S.

EXTERNAL ANATOMY. The worms are relatively large and stout, measuring up to 50 mm. in length and having a maximum breadth of 1.5 mm. They are composed of numerous thick segments, with slightly salient posterior margins, the last segment measuring 2 mm. in length and 1.4 mm. breadth ; the genital pores are irregularly alternate and are situated in the posterior third of the segment.

Head. The head is very small and somewhat heart-shaped, the pointed extremity being directed anteriorly. It has a maximum width of 750μ and a length of 850μ . The two bothridia are small, having a breadth of 530μ and a length of 470μ ; their margins are entire and only slightly thickened. The proboscis sacs are situated almost immediately behind the posterior margins of the bothridia and they have a length of 245μ and a maximum breadth of 110μ . The neck measures about 220μ in length; anteriorly it is somewhat thickened and the posterior extremity of the proboscis sacs lie in the thickened portion. The armed portion of the proboscides and the proboscis sheaths are each about as long as the bothridia.

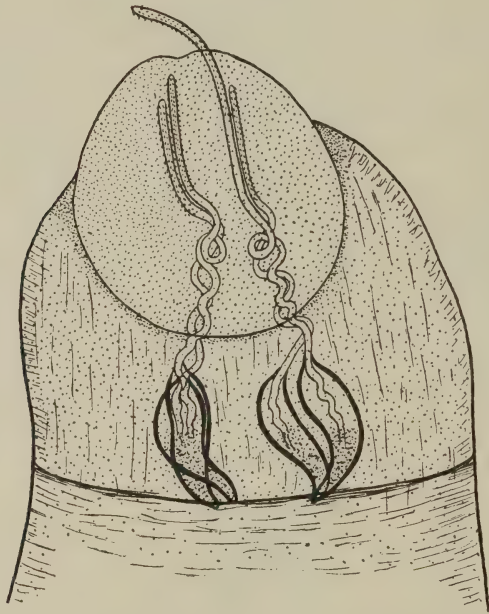
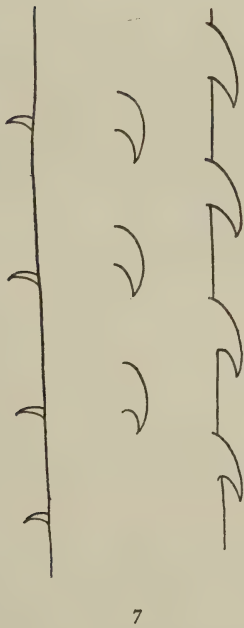


FIG. 9. *Rhynchobothrius rhynchobatidis*. Head. $\times 69$.

Hooks. The hooks on the proboscides appeared to be arranged irregularly and not, as is usual, in rings or in spirals. The internal face of each proboscis bears a longitudinal row of rose-thorn shaped hooks 8μ in length arising from a base also 8μ in length. Ventrally there are three or four longitudinal rows of smaller rose-thorn shaped hooks, two longitudinal rows of which have their points directed anteriorly instead of posteriorly; in Shipley and Hornell's specimens,



FIGS. 5 to 8. *Rhynchobothrius rhynchobatidis*. Hooks from various parts of proboscis. $\times 1125$.

only one longitudinal row of hooks pointed anteriorly. Dorsally there are two more rows of small rose-thorn shaped hooks gradually changing in shape both dorsally and ventrally into about two longitudinal rows of very slender, sabre-like hooks, also 8μ in length on the external face of each proboscis. The neck is very short, measuring only 200μ in length.

INTERNAL ANATOMY. *Muscular system.* The longitudinal muscular system is strongly developed and consists dorsally and ventrally of a single row of oval bundles. Laterally the bundles are much smaller and scattered about irregularly.

Excretory system. This consists of two vessels on each side, the internal vessel is large and the external vessel (which lies directly external and close to the large vessel) is very small.

Details of the nervous system were not investigated. The cortical and medullary parenchyma is strongly developed.

Genitalia. Testes. These are very numerous and fill the dorsal part of the segment in front of the ovary. In the early stages of development they are crowded together in the median field, on each side of the mid-antero-posterior axis. The cirrus pouch is conspicuous and extends one-third the distance across the segment; no spines were observed on the cirrus. Posterior and median to the pouch the vas deferens forms a number of conspicuous coils.

Ovary. This is, as usual, a bilobed organ situated posteriorly; the vagina is a short, coiled tube which runs ventral (?) to the pouch and opens to a shallow genital atrium.

Shell gland. This is a conspicuous organ lying posterior to the ovary.

Vitelline glands. These completely encircle the segment and are situated in the cortical parenchyma.

Uterus. This arises as a closely coiled tube running to the extreme anterior margin of the segment; eventually it entirely fills the segment, and is distended with eggs, none of which, however, were mature.

DIAGNOSIS. This species resembles *T. rhynchobatidis* generally, and in particular in having certain hooks on the proboscides pointing anteriorly, and in the pore being situated posteriorly. It appears to differ from it, however, in the shape of the head generally, in the form of the bothridia, and in having a double row of hooks pointing

anteriorly. The worm has also a somewhat close resemblance to that of *R. curtum*, Linton, 1909, from which it only differs: (1) in being much larger, (2) in the relative size of the bothridia to the rest of the head, and (3) in the form and size of the posterior segments.

The armature of the proboscides in *R. curtum* has not been described.

These differences, however, do not appear to the author to be of much specific value and accordingly the worm described above, and also Linton's *R. curtum*, are considered identical with *T. rhynchobatidis*, Shipley and Hornell, 1906.

Rhynchobothrius longicollis (van Ben., 1849) (fig. 10).

SYNONYM:—*Tetrarhynchus leucomelanus*, Shipley and Hornell, 1906.

One specimen of what appears to be this species was obtained by the author from *Trygon sephen*, Portugal Bay, November 7th, 1910; other specimens from *Rhynchobatus djeddensis*, February 3rd, 1911; *Trygon kuhli* and *Trygon walga*, November 27th, December 3rd, 1910, and February 7th and February 21st, 1911.

Shipley and Hornell gave the following diagnosis of this species:—

‘Five centims. to eight centims. long, with posteriorly thick, stout proglottides, three millims. broad. Anterior half or two-thirds of the preserved body white, the remainder slaty black, deepening into a dense black. When alive, milky white, with a pink patch behind the proboscis sheath. Head with shallow lappets, well defined. Proboscides with an enormous number of very minute teeth, all uniform size and shape, arranged in rings and longitudinal rows. The proboscis sacs are very long, occupying seven-tenths of the length of the head. There is a short neck; the posterior edge of each proglottis is salient. Generative pores irregularly alternate. Habitat:—Intestine of *Trygon sephen*.’

The specimens agree closely with Shipley and Hornell's description of this species. The hooks on the proboscides are all alike and are extremely minute. As the anatomy of this species has not been described, the following notes are added:—The genital pores are irregularly alternate and are situated a little distance behind the middle of the lateral margin of the segment.

Testes. The testes vary in number from about 165 to 210; they occupy the entire dorsal area in front of the ovary. Aporally there are from about 90 to 110 testes; and porally there are from about 25 to 40 testes posterior to the cirrus pouch, and about 50 to 60 anterior to that organ.

Vas deferens. The cirrus pouch is small and almost globular, not measuring more than one-fifth the transverse axis of the segment. From the preparations it was impossible to decide whether the cirrus was armed or not. Median to the pouch the vas deferens forms a conspicuous coiled mass.

Ovary. This is a large bilobed organ situated posteriorly. Details relating to the vagina could not be made out in whole mounts.

Vitelline glands. These encircle the entire segment except for a small area dorsally and ventrally.

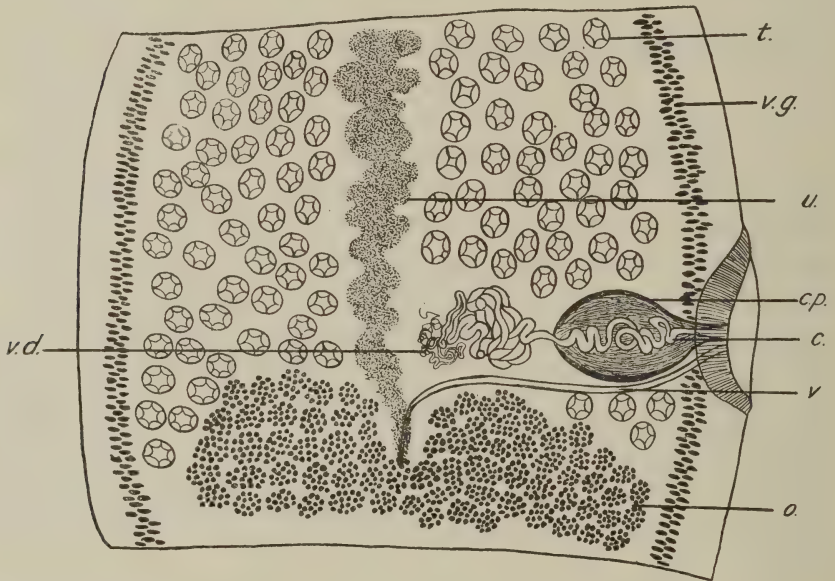


FIG. 10. *Rbyncobothrius longicollis*. Mature segment. *t.*—testes; *v.g.*—vitelline glands; *u.*—uterus; *c.p.*—cirrus pouch; *c.*—cirrus; *v.*—vagina; *o.*—ovary; *v.d.*—vas deferens. $\times 69$.

Uterus. At first this consists of a coiled tube running in the median line from the ovary to the extreme anterior margin of the segment. When fully developed it consists of a bag with sacculated walls entirely filling the segment. The uterus was full of immature eggs.

Shiple and Hornell's species is indistinguishable from, and *T. ruficollis* (Eysenh., 1829) is closely related to, *Tetrarhynchus longicollis*, van Ben., 1849.

Rhynchobothrius spinuliferus (Southwell, 1911).

SYNONYMS :—*Tetrarhynchus spinulifera*, Southwell, 1911.

Rhynchobothrium laciniatum, Yoshida, 1917.

Two specimens were examined, taken from the intestine of *Rhynchobatus djeddensis*, Ceylon Pearl Banks, 1908.

EXTERNAL ANATOMY. The worm measures up to 5.5 cms. in length and the greatest breadth is 1 mm. It is composed of a large number of segments, the last measuring about 1.3 mm. in length. The posterior margins of the segments are produced into long digitate flaps with pointed extremities; these laciniae are small in the neck region and short and blunt in gravid segments. The pores are situated laterally at the junction of the anterior two-thirds and posterior third of the segment. A uterine pore was present on the ventral surface; the segments do not leave the chain until the uterus is fully mature. The neck is short, measuring only about 250 μ .

Head. The head is very small, measuring 1 mm. in length; its breadth at the bulbs is 120 μ , and in the vicinity of the sheaths, 76 μ ; the two bothridia measure 126 μ in length and 90 μ in breadth; the proboscis sheaths form long, dense, spiral coils, and the proboscis sacs measure 280 μ in length and 27 μ in breadth. Unfortunately, the proboscides were not protruded and consequently details relating to the spines cannot be given. The entire head is covered with very minute spinules.

INTERNAL ANATOMY. Owing to the scarcity of material the muscular, excretory and nervous systems were not examined.

Testes. The number of testes could not be counted, as the worms were not well-preserved.

Vas deferens. The cirrus pouch is large, extending to the median longitudinal axis of the segment. The cirrus is dilated near the pore, and a number of coils of the vas deferens lie within the pouch. Outside the pouch the vas deferens forms a small coiled mass near the median extremity of the pouch.

Ovary. This is a bilobed organ situated posteriorly and comprised of a few, large, club-shaped acini. When fully mature the acini appear to fuse on each side, giving the ovary a dumb-bell appearance.

Vagina. Unfortunately, details relating to this organ could not be made out.

Vitelline glands. These encircle the entire segment and are composed of large acini.

Uterus. This develops early as a tube with very thick lobulated lateral walls; it eventually fills the entire segment. A uterine pore is situated ventrally near the median extremity of the cirrus pouch; it has a muscular margin.

Eggs. No fully ripe eggs were seen; of those observed some were flask-shaped, with a number of short filaments at one end, whilst others were somewhat kidney-shaped, with a number of short filaments at both extremities.

There is no room for doubt that *R. laciniatum*, Yoshida, 1917, is identical with *R. spinuliferus* (Southwell, 1911).

Rhynchobothrius carcharidis, Shipley and Hornell, 1906.

SYNONYM:—*Tetrarhynchus carcharidis*, Shipley and Hornell, 1906.

Two specimens of what appears to be this species were obtained from the intestine of *Trygon walga*, Ceylon Pearl Banks, 1910; collected by the author.

EXTERNAL ANATOMY. The worms measured up to 25 mm. in length and the greatest breadth was about 1 mm.; the last segment, which was gravid, measured 1.2 mm. in length, and 1 mm. in breadth; in all, about ninety segments were counted under magnification, but only the last ten or so were relatively large. The genital pores are irregularly alternate and are situated laterally in the posterior third of the segment.

Head. The length of the head cannot be given, as it passes imperceptibly into the neck. The length from the anterior extremity to the proboscis bulbs is 1.5 mm. and its breadth is 0.4 mm. The two bothridia measure 0.5 mm. in length and 0.37 in breadth; their margins are not thickened. The proboscides are armed with a large number of extremely small uniform hooklets. The neck is short, but varies in length.

INTERNAL ANATOMY. The muscular, excretory and nervous systems were not investigated.

Testes. These are very numerous and lie on each side of the median longitudinal axis until they are mature, when they completely fill the central field.

Vas deferens. The cirrus pouch is pyriform and extends almost to the centre of the segment; within it the vas deferens lies in several coils; it was impossible to decide, in whole mounts, whether the cirrus was armed or not.

Ovary. This is a very massive, bilobed organ situated posteriorly, and composed of acini densely crowded together; the vagina could not be traced in whole mounts.

Uterus. This appears very early and at first consists of a tube running in the median longitudinal axis of the segment. Its lateral walls become lobulated, and eventually it fills the segment and becomes full of eggs; the latter were immature and, in whole mounts, details relating to them could not be ascertained.

The worm agrees with Shipley and Hornell's description of this species except that it is larger, contains more segments, and these are not so elongated as in the type species. In all probability, Shipley and Hornell's specimen was immature and had been preserved in an elongated condition.

Rhynchobothrius binuncus, (Linton, 1909).

SYNONYM :—*Rhynchobothrium binuncum*, Linton, 1909.

One specimen of this worm was obtained by the author from the intestine of *Trygon* sp. (*walga* ?), Ceylon Pearl Banks, 27.II.10.

The species is distinguished by the peculiarly shaped hooks on the proboscides, by the worm being composed of about seven segments—the last being almost as large as the remainder of the worm,—and by the pore being situated in the posterior third of the segment.

Syndesmobothrium, Diesing, 1863.

SYNONYM :—*Symbothrium*, Diesing, 1850.

This genus is characterised by Diesing as follows :—

Body articulate, taeniaeform; neck tubular, rounded at the base; head tetragonal, with four terminal prominent bothria attached to head by posterior margin, cruciformly disposed, oval, slightly convex, joined with each other at the base by a membrane; proboscides four, filiform, armed, each one running through a bothrium (pedicel), excurrent at apex, long, retractile in the neck. Genital apertures marginal (?). In intestines of marine fishes of tropical America (after Linton).

Syndesmobothrium rubromaculatum (Diesing, 1863) (fig. 11).

SYNONYMS :—*Tetrarhynchus rubromaculatus*, Diesing, 1863.

Tetrarhynchus platycephalus, Shipley and Hornell, 1906.

One specimen of what appears to be this species was collected by the author from the intestine of *Trygon kuhli*, Ceylon Pearl Banks, 1910. The proboscides were not protruded and it was therefore impossible to see the hooks properly. At least one longitudinal row appeared to point anteriorly. The worm is



FIG. 11. *Syndesmobothrium rubromaculatum*. A hook, from proboscis. $\times 500$.

composed of about ten segments, the last one being greatly elongated. The genital pore is situated in the posterior third of the segment. As the only specimen available was in poor condition, the general anatomy of the worm could not be made out. The species is somewhat closely related to *Rhynchobothrium benedeni* (Crety, 1890).

Otobothrium, Linton, 1890.

Body articulate, taeniaeform, head separated from body by a neck. Bothria two, opposite, lateral, each with two supplemental ciliated pits at the posterior free angles. Proboscides four, terminal, filiform, armed, retractile in neck. Reproductive apertures marginal (Linton).

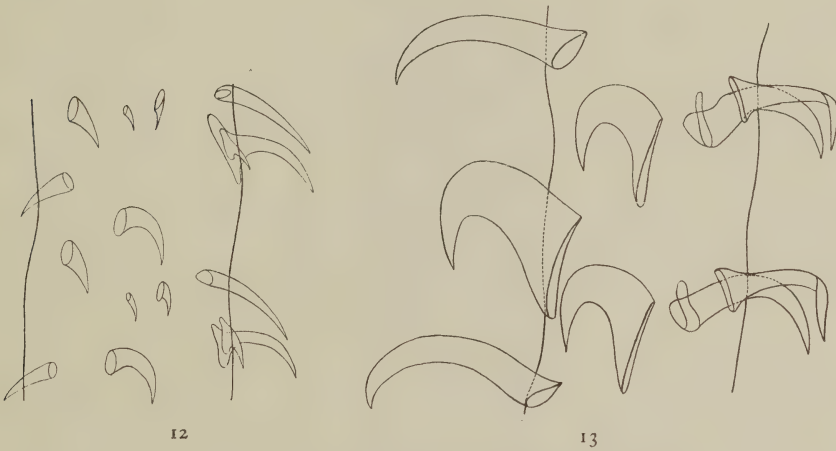
Otobothrium magnum, n.sp. (figs. 12-14).

Three specimens collected by the author from the intestine of *Rhynchobatus djeddensis*, Pearl Banks, Ceylon, 25.4.1909.

EXTERNAL ANATOMY. The worms measure about 35 mm. in length and have a maximum breadth of about 0.5 mm.; there are about fifty segments, the last one measuring from 2 to 3 mm. in length. The lateral margins are straight and the posterior margins are not salient; the genital pores are irregularly alternate and are

situated on the lateral margin, in the posterior third of the segment. The neck is very short, measuring only 60μ in length.

Head. The entire head has a length of 4.5 mm. and a maximum breadth of 1.3 mm. ; the two bothridia each have a length of 1 mm. ; the proboscis sacs have a length of 1.75 mm. and are marked by fine diagonal lines crossing each other at right angles. The proboscis sheaths are spiral, and those portions lying posterior to the bothridia have a length of 1.75 mm. The proboscides are practically as long as the entire head, and are armed with hooks of various sizes and shapes arranged in horizontal rings. The hooks towards the tip are smaller



FIGS. 12 and 13. *Otobothrium magnum*, n.sp. Hooks from different parts of proboscis. $\times 250$.

than the rest ; in each ring there are eight or nine hooks, the smallest hooks being situated in an antero-posterior line and the largest hooks on another antero-posterior line on the opposite side of the proboscis. Hooks of intermediate size and shape occur on the portions of the proboscides between these two lines.

INTERNAL ANATOMY. Owing to the material being scanty, the muscular, excretory and nervous systems were not investigated.

Testes. These first appear in about segment 32 and number about 300 ; their arrangement is peculiar in that about 50 testes lie posterior to the ovary and a separate cluster of about ten testes lie near the median extremity of the cirrus pouch. The remaining testes are distributed on each side of the middle line, in front of the ovary. The cirrus pouch was not fully developed and therefore

cannot be described ; it appeared, however, to lie internal to the water vessels and to extend to the median antero-posterior axis.

Ovary. The ovary was rudimentary, bilobed, and situated a little distance from the posterior margin of the segment.

Uterus. This organ was also in a rudimentary condition and consisted of a slight irregular thickening running along the median antero-posterior axis of the segment.

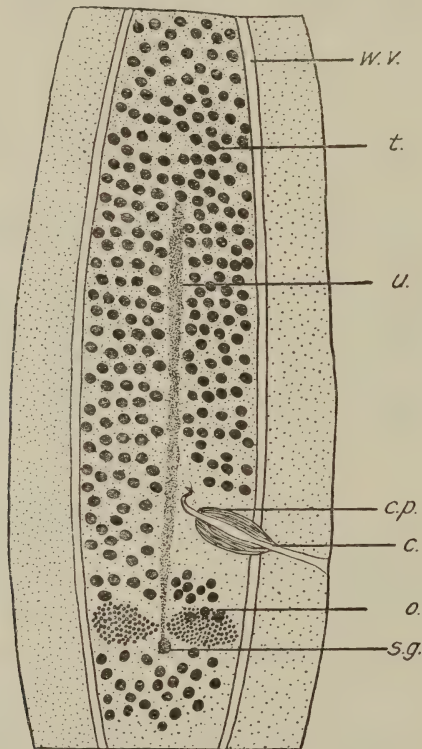


FIG. 14. *Otobothrium magnum*, n.sp. Mature segment. *w.v.*—water vessel ; *t.*—testes ; *u.*—uterus ; *c.p.*—cirrus pouch ; *c.*—cirrus ; *o.*—ovary ; *s.g.*—shell gland. $\times 112$.

DIAGNOSIS. There are only four species belonging to this genus and they have all been described by Linton, viz.,

O. crenacolle, Linton, 1890 (described from an adult worm) ;

O. dipsacum, Linton, 1897 (described from a larva) ;

O. insigne, Linton, 1905 (described from a specimen not fully adult) ;

O. penetrans, Linton, 1907 (described from a larva).

O. crenacolle measures about 14 mm. in length, is composed of about twelve segments ; the genital pores are situated at the middle of the lateral margin of the segment.

O. insigne. In this species the genital pore is situated in front of the middle of the lateral margin of the segment ; the head terminates posteriorly in a ' collar ' which surrounds the anterior part of the strobila. The worm was not fully mature ; it measured 10 mm. in length and was made up of twelve segments.

O. penetrans. In this species the chief characteristic appears to be the fact that, posteriorly, the proboscis sacs are divergent.

O. dipsacum. The chief characteristics of this species (which, as noted above, was described from a larva) is the fact that each proboscis

' Has a longitudinal line towards which the short diagonal rows of hooks converge on each side. Near the base of the proboscides, where the hooks are somewhat scattered, from six to ten hooks to a row could be counted on each sac of the horizontal line under favourable circumstances. More than twice that number could be counted in the rows nearer the apex of the proboscis.'

O. magnum, n.sp., resembles *O. dipsacum* in having an antero-posterior line on each proboscis towards which the hooks gradually get smaller, but the number of rows of hooks is much less than that given for *O. dipsacum* and they differ also in shape. For these reasons the species is separated from all the species of *Otobothrium* hitherto described. It further differs from *O. crenacolle* and *O. insigne* in size and in the position of the genital pore. Type species are in the Liverpool School of Tropical Medicine.

Otobothrium dipsacum, Linton, 1897.

Several large larvae from the mesenteries of *Serranus undulosus*, South Silavaturia, Ceylon Pearl Banks. Collected by the author, April 2nd, 1909 ; also from *Diagramma crassispinum*, and *Balistes* spp., Ceylon Pearl Banks.

Genus *Coenomorphus*, Loennberg, 1889, emended.

With the characters of the family.

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